

## 299-E28-16 (A6794) Log Data Report

### Borehole Information:

|                                     |              |                                     |                                  |                         |             |
|-------------------------------------|--------------|-------------------------------------|----------------------------------|-------------------------|-------------|
| <b>Borehole:</b> 299-E28-16 (A6794) |              | <b>Site:</b> 216-B-12 Crib          |                                  |                         |             |
| <b>Coordinates</b> (WA State Plane) |              | <b>GWL (ft)<sup>1</sup>:</b> 306.51 | <b>GWL Date:</b> 5/16/03         |                         |             |
| <b>North</b>                        | <b>East</b>  | <b>Drill Date</b>                   | <b>TOC<sup>2</sup> Elevation</b> | <b>Total Depth (ft)</b> | <b>Type</b> |
| 136,562.64 m                        | 573,136.75 m | Nov. 1968                           | 215.422 m                        | 317.8                   | Cable tool  |

### Casing Information:

| Casing Type   | Stickup (ft) | Outer Diameter (in.) | Inside Diameter (in.) | Thickness (in.) | Top (ft) | Bottom (ft) |
|---|--------------|----------------------|-----------------------|-----------------|----------|-------------|
| Threaded Steel  | 2.4          | 6 5/8                | 6                     | 0.3125          | 0        | 325         |
| The logging engineer measured the casing stickup using a steel tape. A caliper was used to determine the outside casing diameter. The caliper and inside casing diameter were measured using a steel tape, and measurements were rounded to the nearest 1/16 in. Casing thickness was calculated. |              |                      |                       |                 |          |             |

### Borehole Notes:

Borehole coordinates, elevation, and well construction information, as shown in the above tables, are from measurements by Stoller and Duratek field personnel, Ledgerwood (1993), and HWIS<sup>3</sup>. Zero reference is the top of the 6-in. casing. A reference point survey "X" is located on top of the casing stickup.

### Logging Equipment Information:

|  |  |
|--|--|
| <b>Logging System:</b> Gamma 1G                  | <b>Type:</b> 35% HPGe                          |
| <b>Calibration Date:</b> 03/2003                 | <b>Calibration Reference:</b> GJO-2003-438-TAC |
| <b>Logging Procedure:</b> MAC-HGLP 1.6.5, Rev. 0 |  |

|  |  |
|--|--|
| <b>Logging System:</b> Gamma 1C                  | <b>Type:</b> High Rate Detector                |
| <b>Calibration Date:</b> 04/2003                 | <b>Calibration Reference:</b> GJO-2003-429-TAC |
| <b>Logging Procedure:</b> MAC-HGLP 1.6.5, Rev. 0 |  |

### Spectral Gamma Logging System (SGLS) Log Run Information:

| Log Run           | 1                | 2       | 3       | 4       | 5/ Repeat |
|-------------------|------------------|---------|---------|---------|-----------|
| Date              | 5/19/03          | 5/20/03 | 5/20/03 | 5/20/03 | 5/20/03   |
| Logging Engineer  | Spatz            | Spatz   | Spatz   | Spatz   | Spatz     |
| Start Depth (ft)  | 318.0            | 149.0   | 106.0   | 97.0    | 140.0     |
| Finish Depth (ft) | 148.0            | 105.0   | 96.0    | 3.0     | 108.0     |
| Count Time (sec)  | 100              | 100     | 10      | 100     | 100       |
| Live/Real         | R                | R       | R       | R       | R         |
| Shield (Y/N)      | N                | N       | N       | N       | N         |
| MSA Interval (ft) | 1.0              | 1.0     | 1.0     | 1.0     | 1.0       |
| ft/min            | N/A <sup>4</sup> | N/A     | N/A     | N/A     | N/A       |

| Log Run                  | 1                        | 2                        | 3  | 4                        | 5/ Repeat                |
|--------------------------|--------------------------|--------------------------|--|--------------------------|--------------------------|
| Pre-Verification         | AG013CAB                 | AG014CAB                 | AG014CAB   | AG014CAB                 | AG014CAB                 |
| Start File               | AG013000                 | AG014000                 | AG014045   | AG014056                 | AG014151                 |
| Finish File              | AG013170                 | AG014044                 | AG014055   | AG0140150                | AG014183                 |
| Post-Verification        | AG013CAA                 | AG014CAA                 | AG014CAA   | AG014CAA                 | AG014CAA                 |
| Depth Return Error (in.) | +1                       | N/A                      | N/A  | -1                       | -1                       |
| Comments                 | No fine-gain adjustment. | No fine-gain adjustment. | Logging parameter change; high dead-time interval. | No fine-gain adjustment. | No fine-gain adjustment. |

### **High Rate Logging System (HRLS) Log Run Information:**

| Log Run                  | 1                        | 2/Repeat        |  |  |  |
|--------------------------|--------------------------|-----------------|--|--|--|
| Date                     | 5/21/03                  | 5/21/03         |  |  |  |
| Logging Engineer         | Spatz                    | Spatz           |  |  |  |
| Start Depth (ft)         | 107.0                    | 102.0           |  |  |  |
| Finish Depth (ft)        | 97.0                     | 98.0            |  |  |  |
| Count Time (sec)         | 300                      | 300             |  |  |  |
| Live/Real                | R                        | R               |  |  |  |
| Shield (Y/N)             | None                     | None            |  |  |  |
| MSA Interval (ft)        | 1.0                      | 1.0             |  |  |  |
| ft/min                   | N/A                      | N/A             |  |  |  |
| Pre-Verification         | AC069CAB                 | AC069CAB        |  |  |  |
| Start File               | AC069000                 | AC069011        |  |  |  |
| Finish File              | AC069010                 | AC069015        |  |  |  |
| Post-Verification        | AC069CAA                 | AC069CAA        |  |  |  |
| Depth Return Error (in.) | N/A                      | -1.5            |  |  |  |
| Comments                 | No fine-gain adjustment. | Repeat section. |  |  |  |

### **Logging Operation Notes:**

Zero reference was top of the 6-in. casing. Logging was performed with a centralizer installed on the sonde. Pre- and post-survey verification measurements for the SGLS were acquired with the Amersham KUT ( $^{40}\text{K}$ ,  $^{238}\text{U}$ , and  $^{232}\text{Th}$ ) verifier with serial number 118. HRLS data were collected using Gamma 1C. Pre- and post-survey verification measurements for the HRLS were acquired with the  $^{137}\text{Cs}$  verifier with serial number 1013.

### **Analysis Notes:**

|                 |         |              |        |                   |                        |
|-----------------|---------|--------------|--------|-------------------|------------------------|
| <b>Analyst:</b> | Sobczyk | <b>Date:</b> | 6/2/03 | <b>Reference:</b> | GJO-HGLP 1.6.3, Rev. 0 |
|-----------------|---------|--------------|--------|-------------------|------------------------|

SGLS pre-run and post-run verification spectra were collected at the beginning and end of the day. All of the pre-run verification spectra were within the control limits. Both of the post-run verification spectra were above the upper control limit for the 609-keV peak counts per second (cps). The counts per second at the 609-keV, 1461-keV, and 2615-keV photopeaks on the post-run verification spectra as compared to the pre-run verification spectra for each day were between 1 percent lower and 7 percent higher at the end of the

day. Examinations of spectra indicate that the detector appears to have functioned normally during logging, and the spectra are accepted.

HRLS pre-run and post-run verification spectra were collected at the beginning and end of the day. The spectra were within the acceptance criteria for the field verification of the Gamma 1C logging system (HRLS).

Log spectra were processed in batch mode using APTEC SUPERVISOR to identify individual energy peaks and determine count rates. Post-run verification spectra were used to determine the energy and resolution calibration for processing the data using APTEC SUPERVISOR. Concentrations were calculated in EXCEL (source files: G1GMay03.xls and G1CApr03). Zero reference was the top of casing. The casing configuration was assumed to be one string of 6-in. casing to 318 ft. The casing correction factor was calculated using a 6-in. casing thickness of 0.3125 in. This casing thickness is based upon the field measurement. A water correction was applied to the data below 306.5 ft.

Using the SGLS, dead time greater than 40 percent was encountered in the interval from 98 to 106 ft, and data from this region were considered unreliable. At SGLS dead time greater than 40 percent, peak spreading and pulse pile-up effects may result in underestimation of activities. This effect is not entirely corrected by the dead time correction, and the extent of error increases with increasing dead time. SGLS dead time corrections were applied when dead time surpassed 10.5 percent. The HRLS was utilized to obtain data where the SGLS dead time exceeded 40 percent.

### **Log Plot Notes:**

Separate log plots are provided for gross gamma and dead time, naturally occurring radionuclides ( $^{40}\text{K}$ ,  $^{238}\text{U}$ , and  $^{232}\text{Th}$ ), and man-made radionuclides. Plots of the repeat logs versus the original logs are included. In addition, a comparison log plot of man-made radionuclides is provided to compare the data collected by Westinghouse Hanford Company's Radionuclide Logging System (RLS) with SGLS data. For each radionuclide, the energy value of the spectral peak used for quantification is indicated. Unless otherwise noted, all radionuclides are plotted in picocuries per gram (pCi/g). The open circles indicate the minimum detectable level (MDL) for each radionuclide. Error bars on each plot represent error associated with counting statistics only and do not include errors associated with the inverse efficiency function, dead time correction, or casing correction. These errors are discussed in the calibration report. A combination plot is also included to facilitate correlation. The  $^{214}\text{Bi}$  peak at 1764 keV was used to determine the naturally occurring  $^{238}\text{U}$  concentrations on the combination plot rather than the  $^{214}\text{Bi}$  peak at 609 keV because it exhibited slightly higher net counts per second.

### **Results and Interpretations:**

$^{137}\text{Cs}$ ,  $^{235}\text{U}$  (based on the 186-keV photopeak), and  $^{238}\text{U}$  (based on the 1001-keV photopeak) were the man-made radionuclides detected in this borehole.  $^{137}\text{Cs}$  was detected from the ground surface to a depth of 39 ft with concentrations ranging from the MDL (0.3 pCi/g) to 0.8 pCi/g.  $^{137}\text{Cs}$  was detected at a depth of 83 ft with a concentration of 0.5 pCi/g.  $^{137}\text{Cs}$  was detected in the interval from 96 ft through 124 ft at concentrations ranging from the MDL to 108,000 pCi/g. The maximum concentration of  $^{137}\text{Cs}$  was measured at 101 ft.  $^{137}\text{Cs}$  was detected in the interval from 231 ft to 237 ft at concentrations ranging from the MDL to 0.9 pCi/g. In addition,  $^{137}\text{Cs}$  was also detected at 212, 279, 291, and 293 ft with concentrations near the MDL (0.3 pCi/g).  $^{235/238}\text{U}$  were detected at 83 ft and in the intervals from 112 through 113 ft and from 150 through 161 ft. Only  $^{235}\text{U}$  was detected at 112 and 113 ft.  $^{238}\text{U}$  concentrations ranged from 17 pCi/g to 85 pCi/g with an MDL of 17 pCi/g.  $^{235}\text{U}$  concentrations ranged from 3 to 8 pCi/g with an MDL of 1.5 pCi/g. The maximum concentrations of  $^{235}\text{U}$  and  $^{238}\text{U}$  were measured at 155 ft. It is probable that  $^{235/238}\text{U}$  exists in the high-activity zone. In this zone, the MDL for  $^{235/238}\text{U}$  increases significantly.

The plots of the repeat logs demonstrate reasonable repeatability of the HRLS and SGLS data.  $^{137}\text{Cs}$  (662-keV) concentrations are comparable between the repeat and original HRLS log runs. The man-made

radionuclides and natural radionuclides at energy levels of 186, 662, 1001, 609, 1461, 1764, and 2614 keV are comparable between the repeat and original SGLS log runs.

Gross gamma logs from Additon et al. (1978) (attached) indicate that the sediments surrounding this borehole contained significant amounts of man-made gamma radiation from 1968 through at least 1976. The log from 11/16/68 appears to detect relatively high gamma activity over the intervals of 49 ft (15 m) to 61 ft (18.5 m), 75 ft (23 m) to 84 ft (25.6 m), and 90 ft (27.3 m) to 118 ft (36 m). The log from 5/5/76 appears to detect relatively high gamma activity only over the interval from 90 ft (27.3 m) to 108 ft (33 m). The SGLS detected  $^{137}\text{Cs}$  and  $^{235/238}\text{U}$  at 83 ft and in the interval from 96 to 124 ft.

Comparison log plots of data collected in 1992 by Westinghouse Hanford Company and in 2003 by Stoller are included. The 1992 concentration data for  $^{137}\text{Cs}$  are decayed to the date of the HRLS logging event in May 2003 and shifted from a ground level reference to a TOC reference. The RLS tool only logged the selected intervals of 0 to 10 ft, 43 to 50 ft, 77 to 112 ft, 143 to 158 ft, and 170 to 180 ft. The RLS tool saturated in the interval from 99 ft to 103 ft. On the 2003 logs, the apparent  $^{137}\text{Cs}$  concentrations are as predicted by decay alone when compared to the 1992 log. Comparing the two logging events, the  $^{235/238}\text{U}$  concentrations appear to agree in the interval from 143 to 158 ft and not in the interval from 81 to 88 ft. The SGLS detected  $^{235/238}\text{U}$  at 83 ft, while the RLS detected  $^{235/238}\text{U}$  in the interval from 81 to 88 ft. Either the SGLS counting times and/or station intervals were inadequate to detect the  $^{235/238}\text{U}$  or the  $^{235/238}\text{U}$  concentrations have decreased in the interval from 81 to 88 ft.

Because of the possibility that  $^{235/238}\text{U}$  movement may have occurred in the vadose zone, it is recommended that this borehole be logged periodically to verify that the change observed in the contaminant profile over the last 10 years has occurred. The interval from ground surface to total depth should be logged again in 5 years. A longer counting time should be used.

## **References:**

Additon, M.K., K.R. Fecht, T.L. Jones, and G.V. Last, 1978. *Scintillation Probe Profiles From 200 East Area Crib Monitoring Wells*, RHO-LD-28, Rockwell Hanford Operations, Richland, Washington.

Ledgerwood, R.K., 1993. *Summaries of Well Construction Data and Field Observations for Existing 200-East Resource Protection Wells*, WHC-SD-ER-TI-007, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

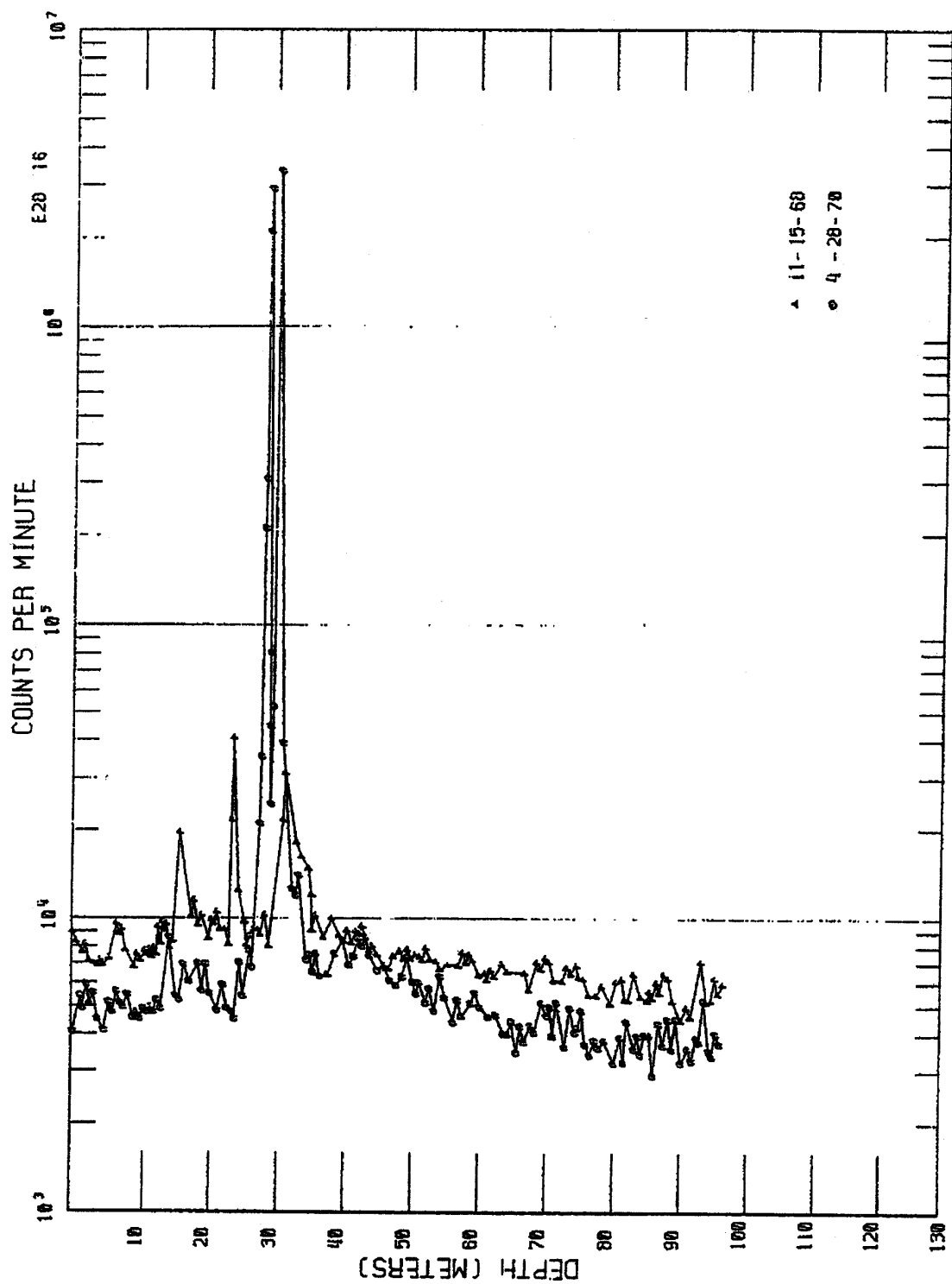
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<sup>1</sup> GWL – groundwater level

<sup>2</sup> TOC – top of casing

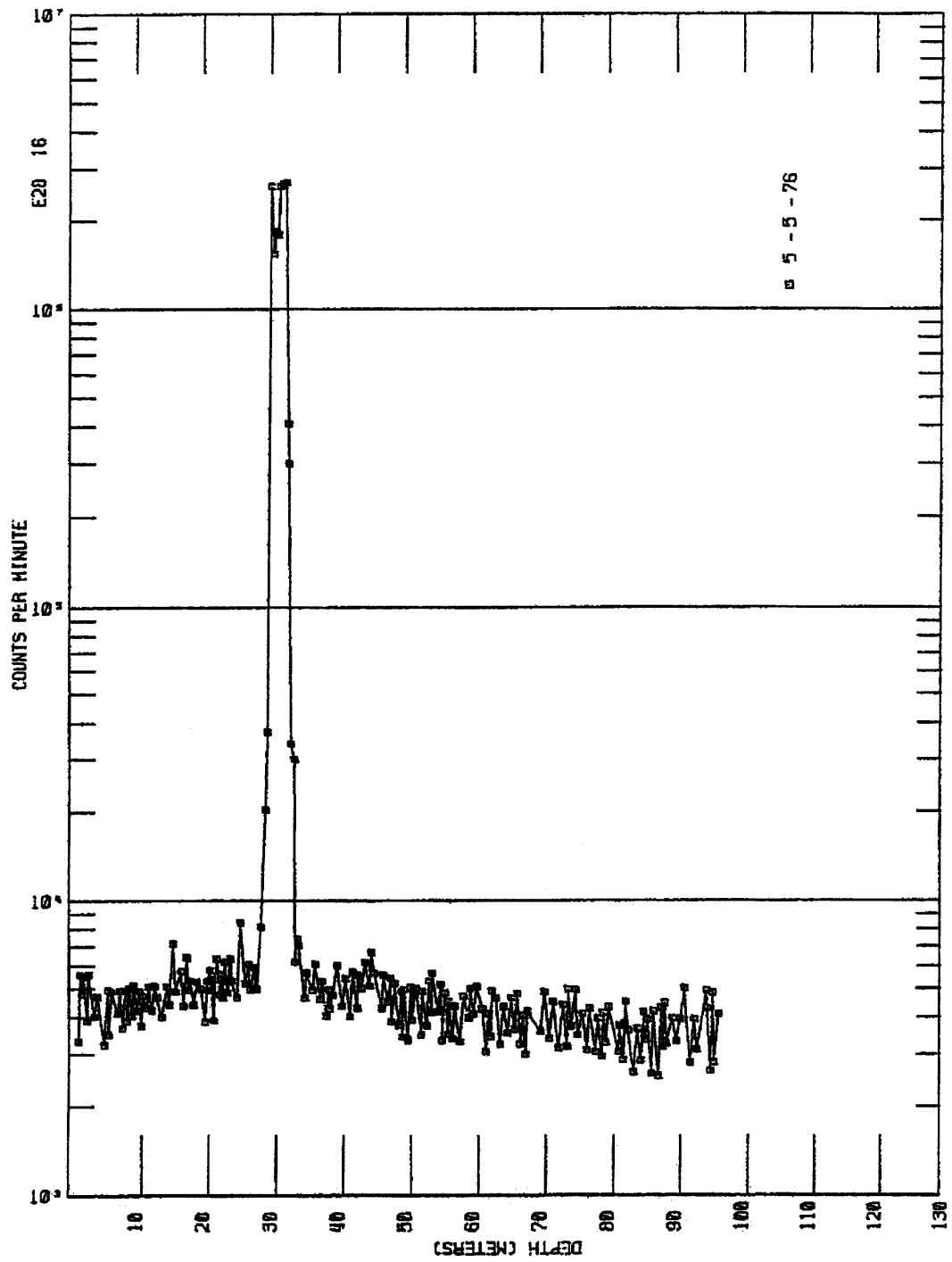
<sup>3</sup> HWIS – Hanford Well Information System

<sup>4</sup> N/A – not applicable



from Additon et al. (1978)

Scintillation Probe Profiles for Borehole 299-E28-16, Logged on 11/15/68 and 4/28/70

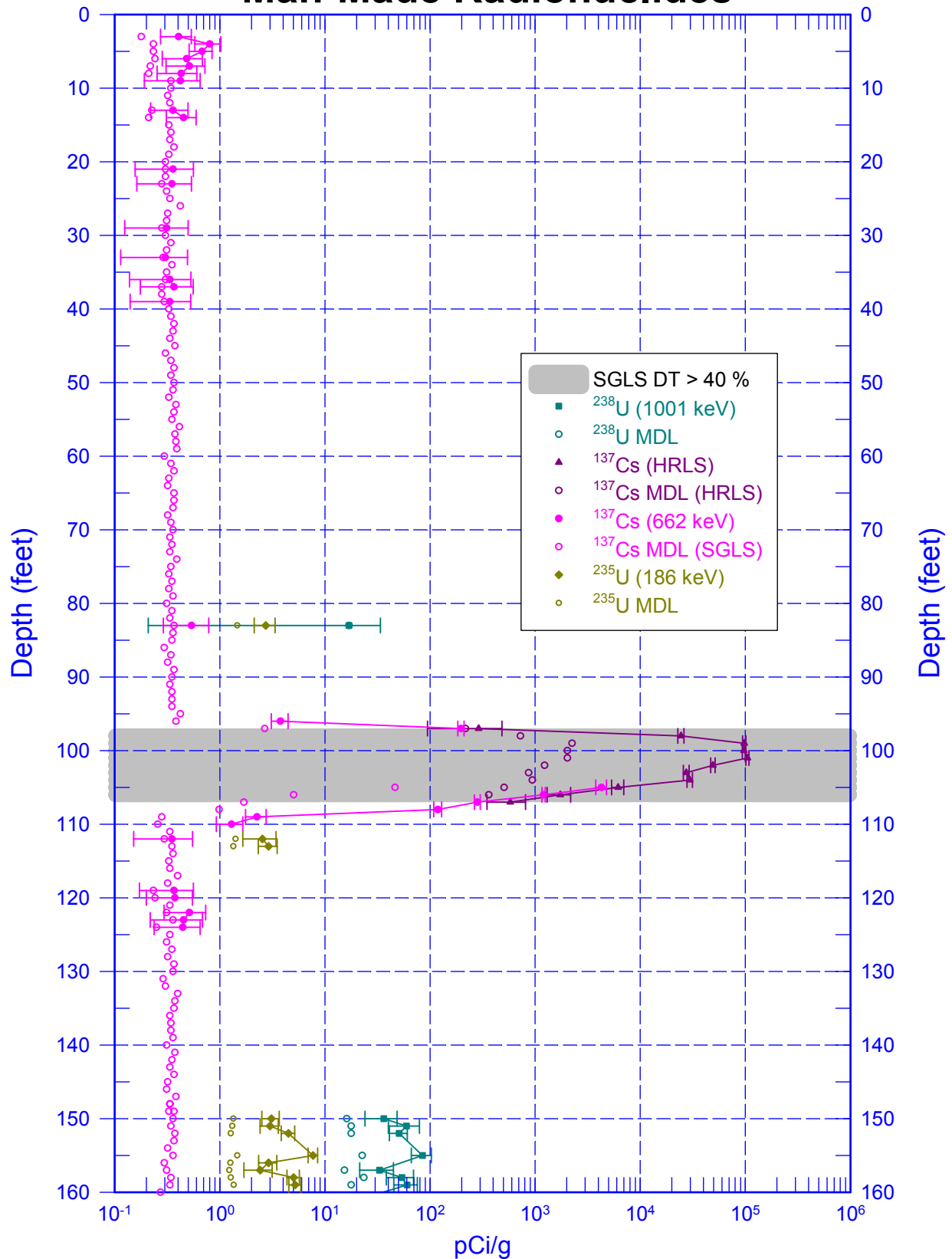


from Additon et al. (1978)

*Scintillation Probe Profile for Borehole 299-E28-16, Logged on 5/5/76*

# 299-E28-16 (A6794)

## Man-Made Radionuclides

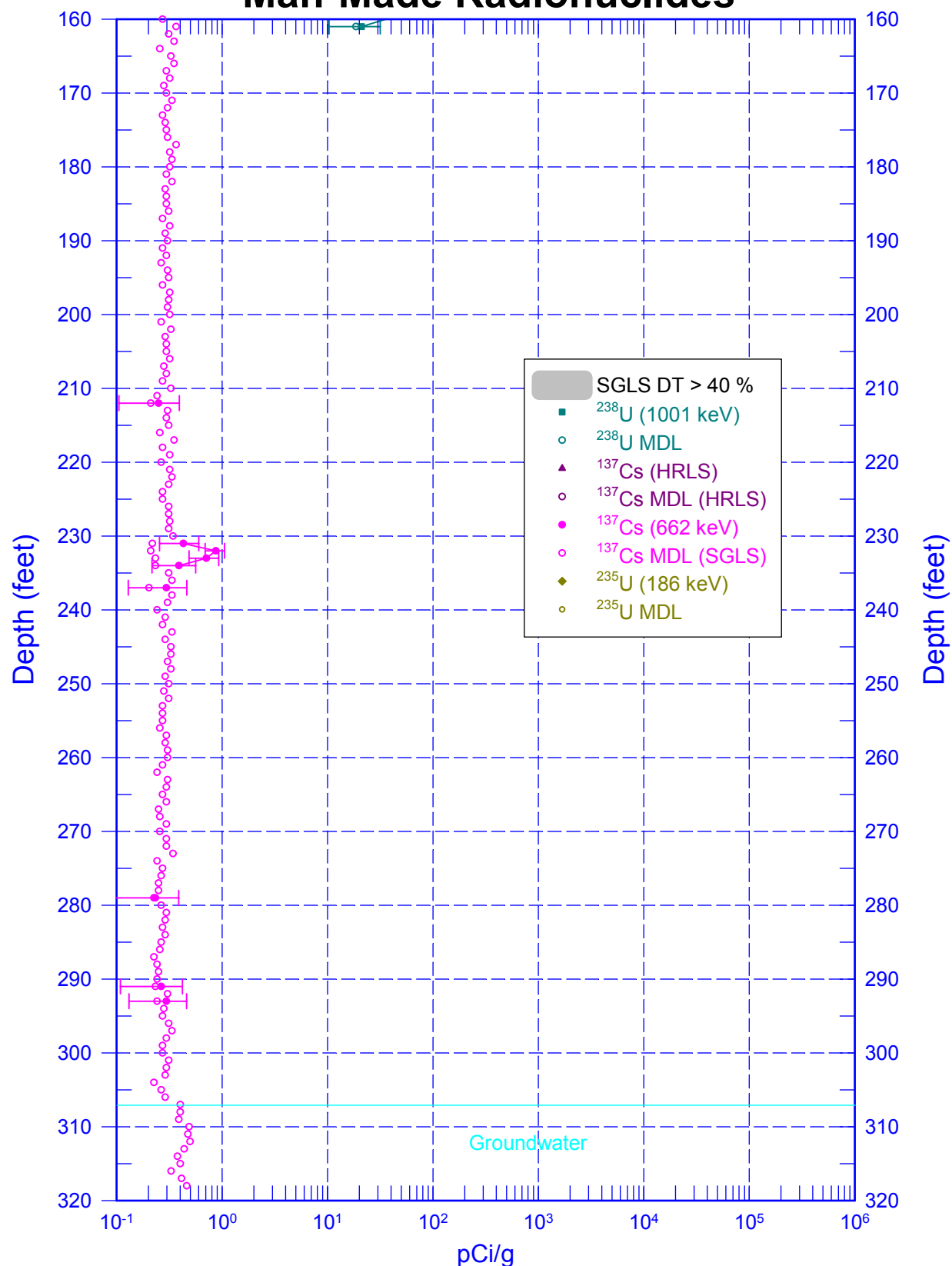


Zero Reference = Top of Casing

Date of Last Logging Run  
5/21/2003

# 299-E28-16 (A6794)

## Man-Made Radionuclides



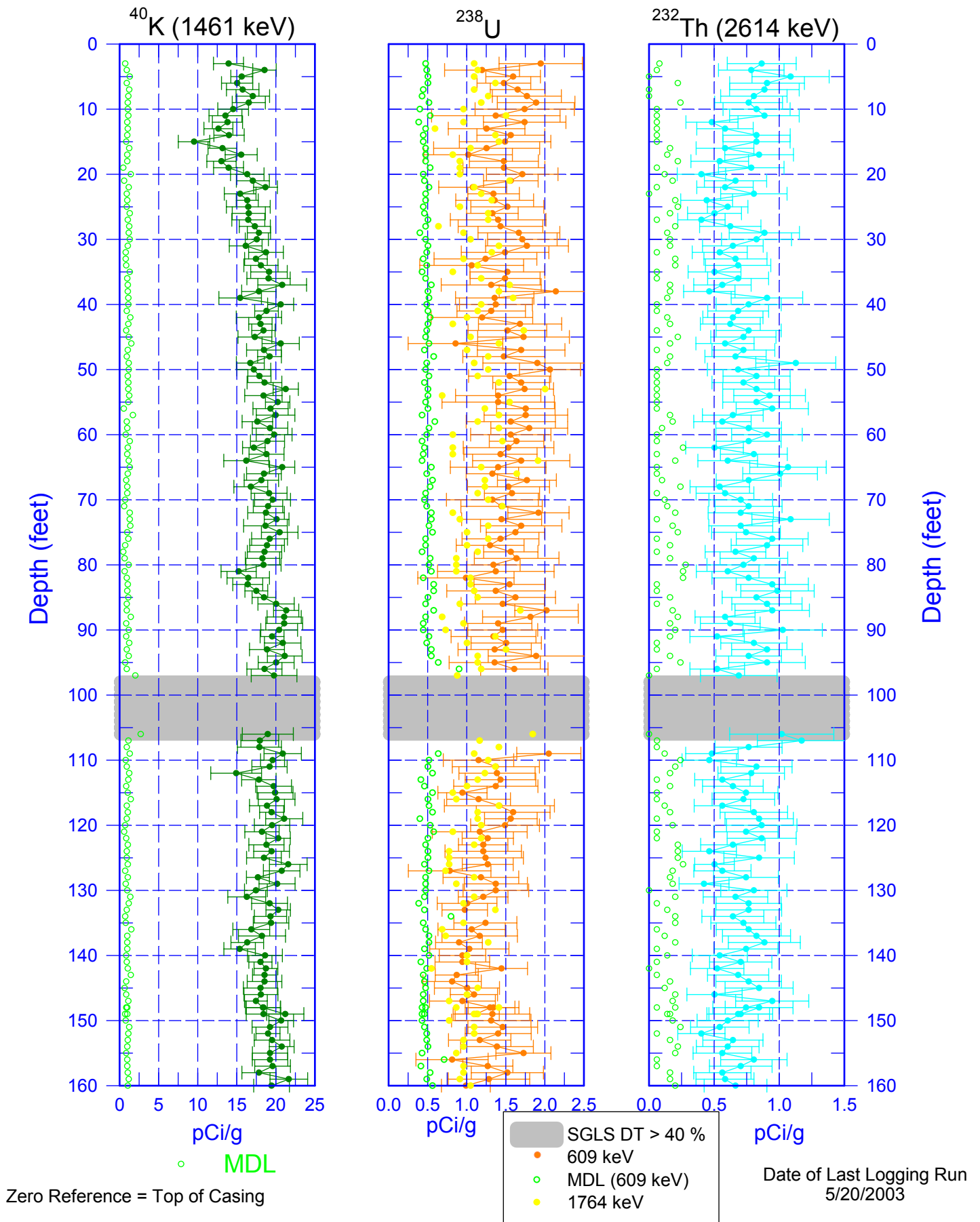
Zero Reference = Top of Casing

Date of Last Logging Run  
5/21/2003



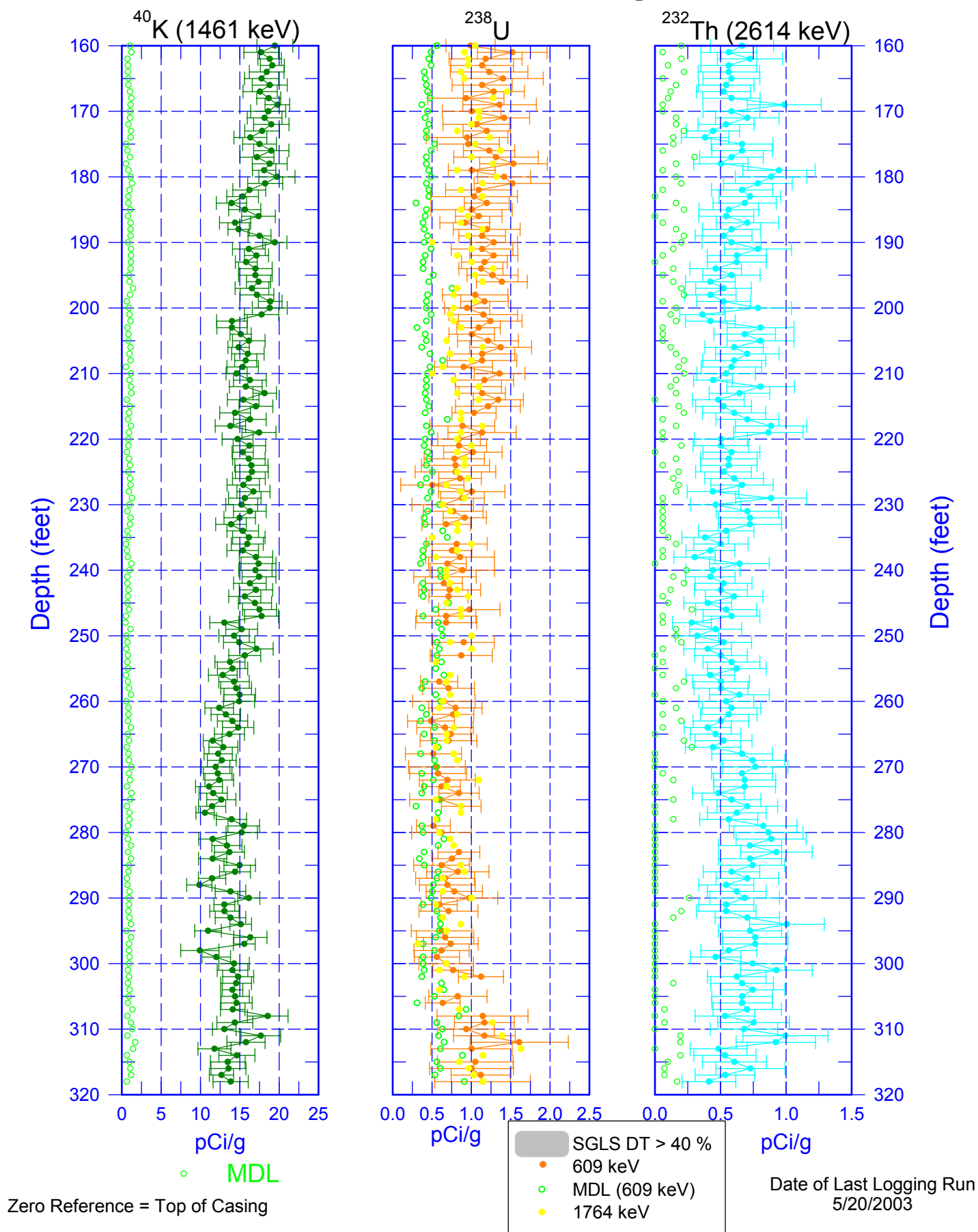
# 299-E28-16 (A6794)

## Natural Gamma Logs

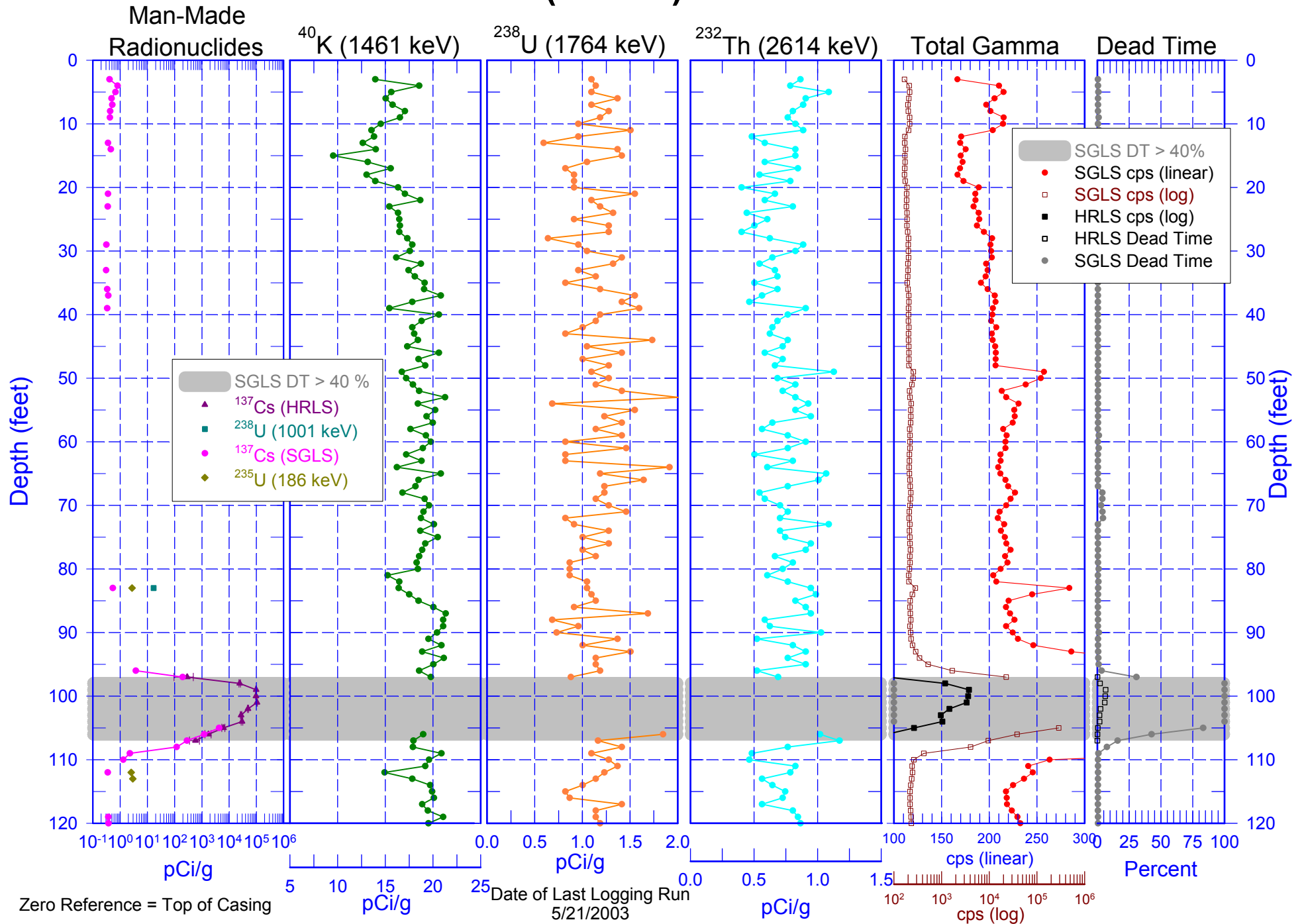


# 299-E28-16 (A6794)

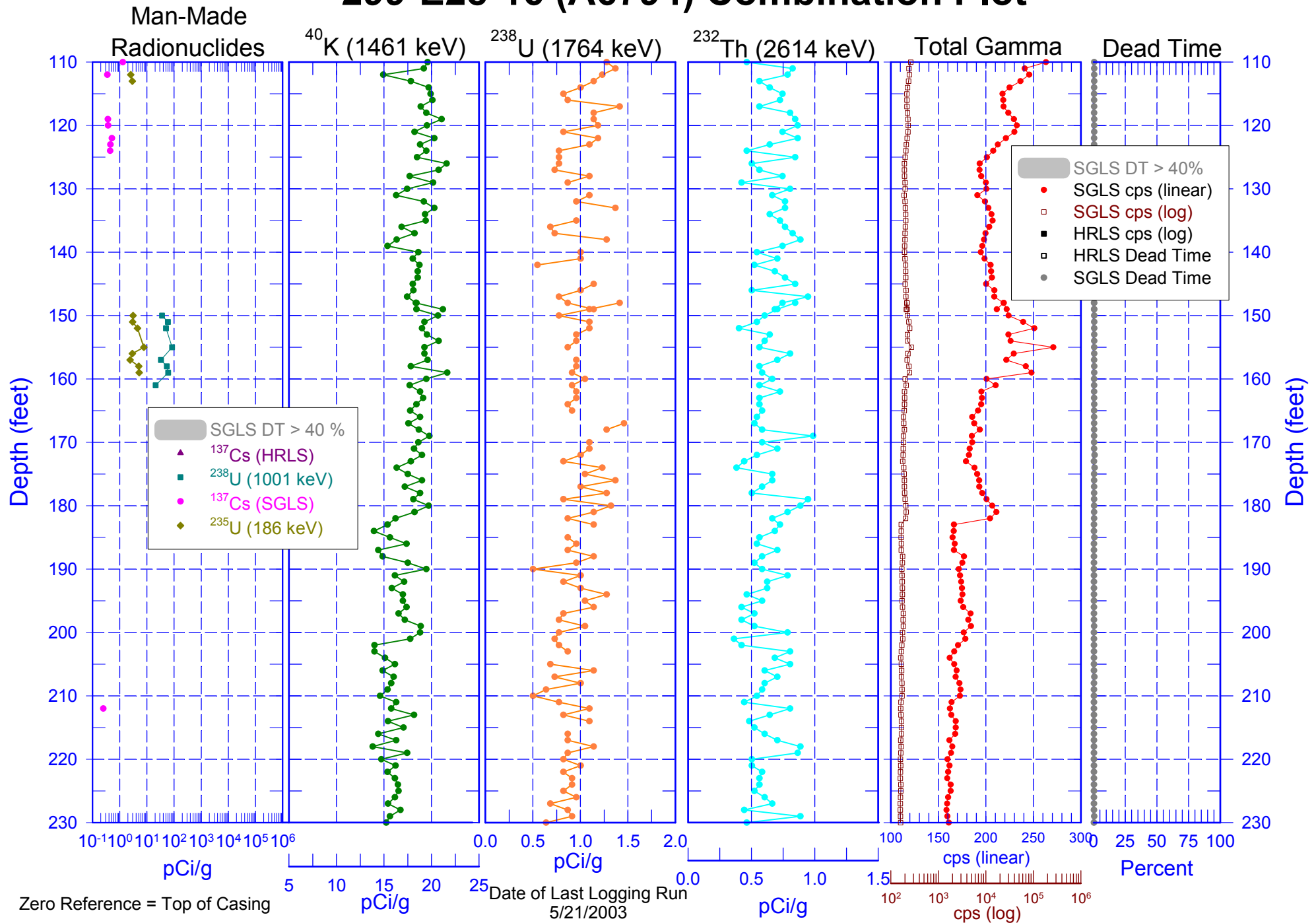
## Natural Gamma Logs



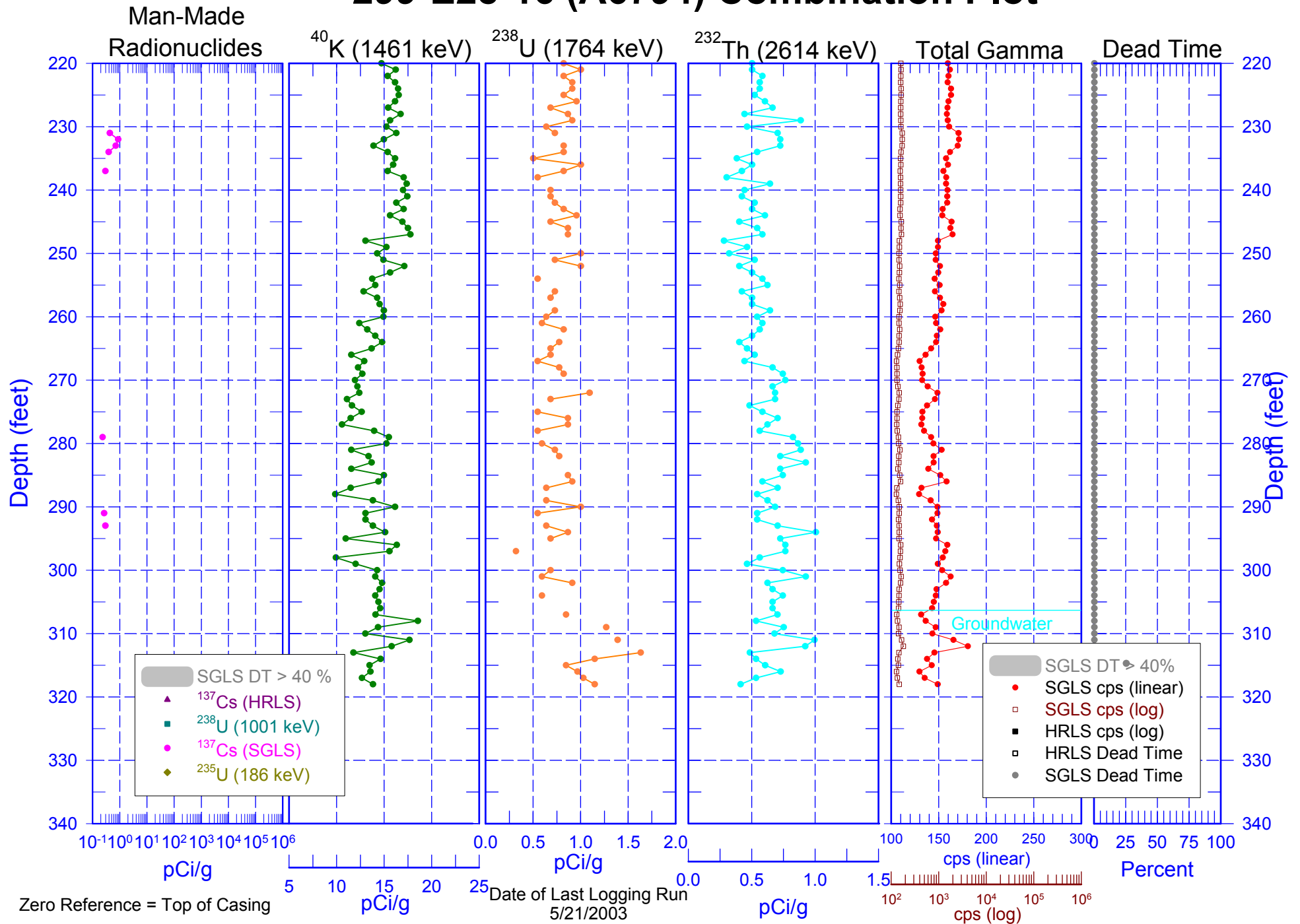
# 299-E28-16 (A6794) Combination Plot



# 299-E28-16 (A6794) Combination Plot

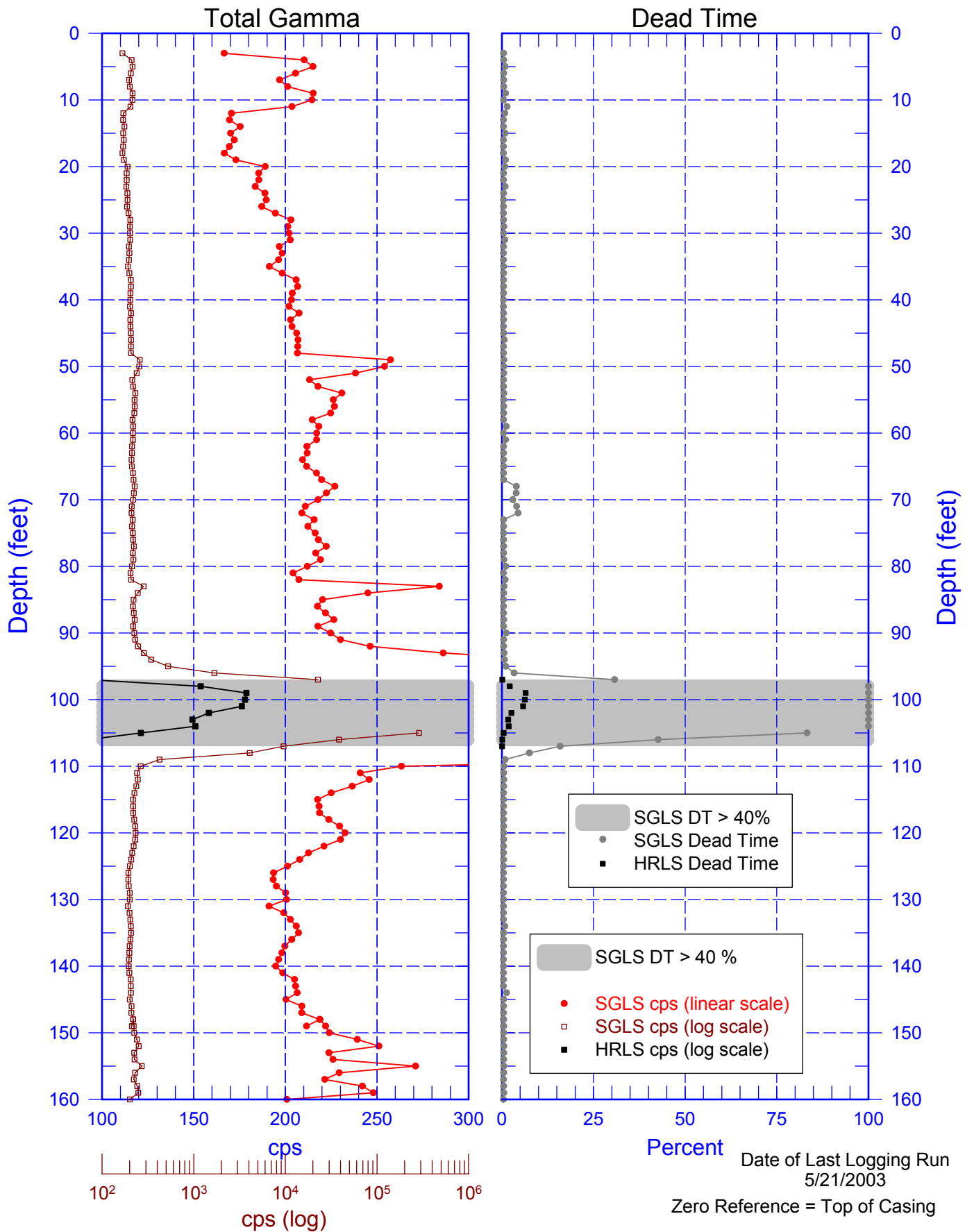


# 299-E28-16 (A6794) Combination Plot



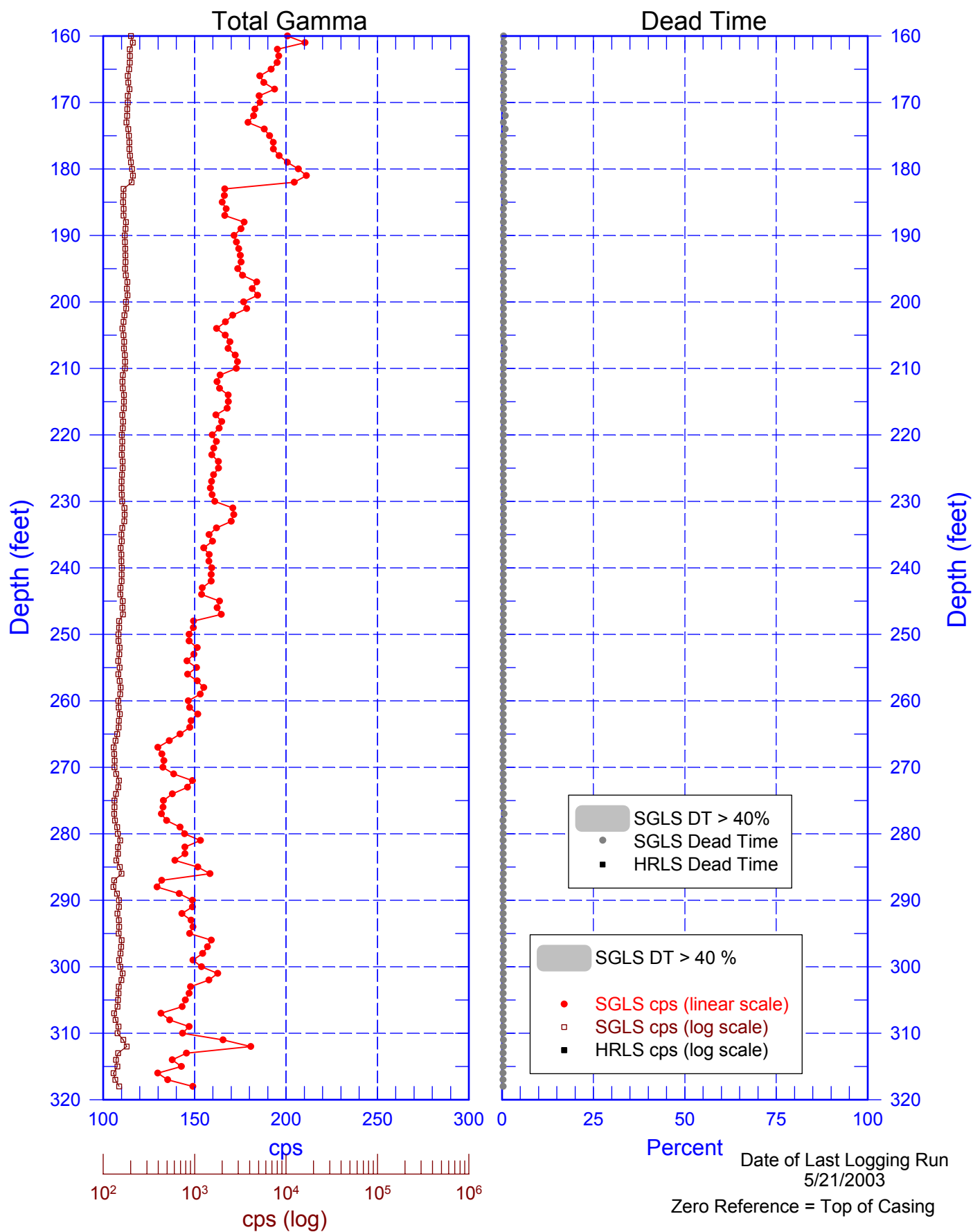
# 299-E28-16 (A6794)

## Total Gamma & Dead Time



# 299-E28-16 (A6794)

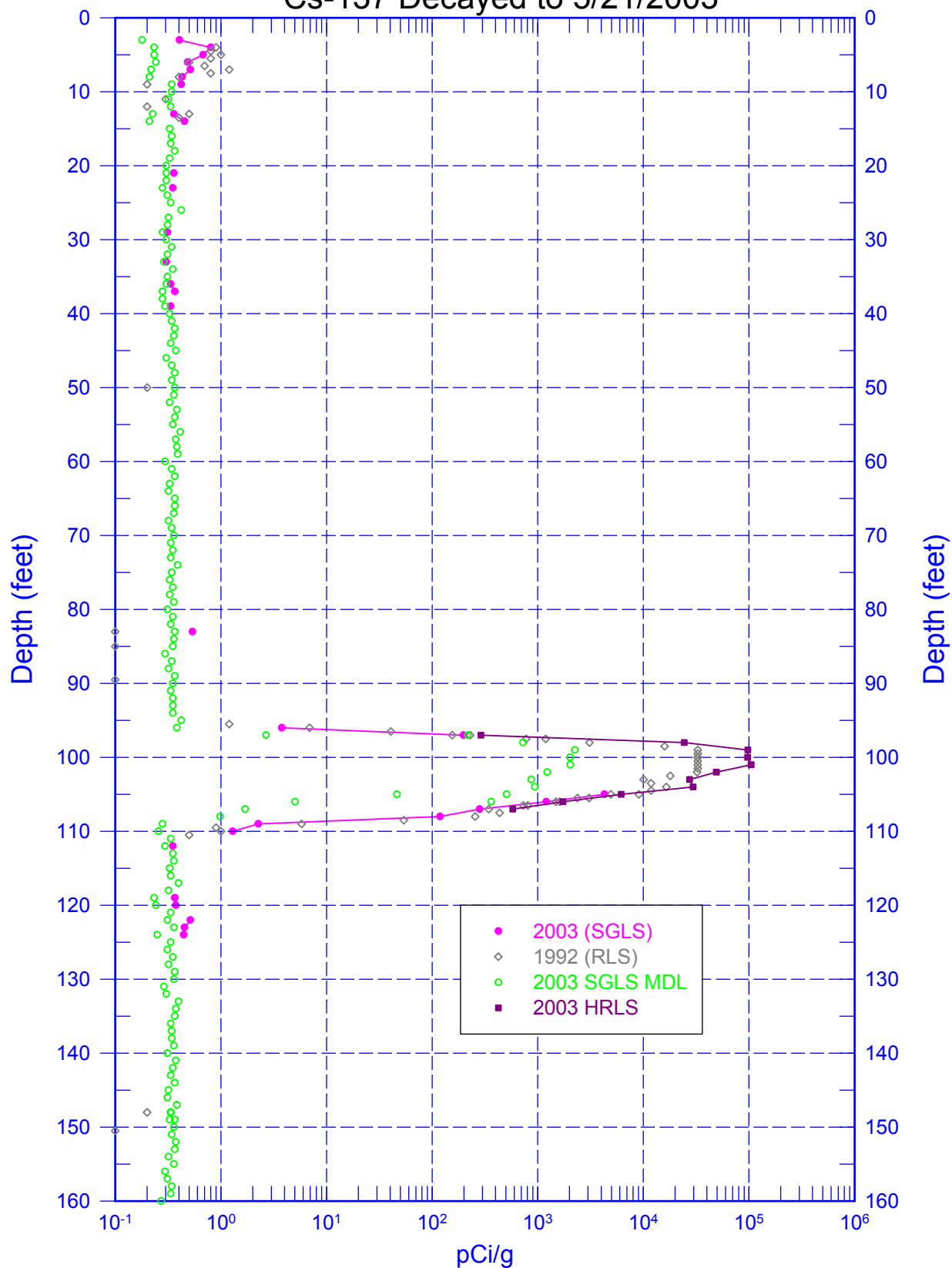
## Total Gamma & Dead Time



# 299-E28-16 (A6794)

RLS Data Compared to SGLS Data

Cs-137 Decayed to 5/21/2003



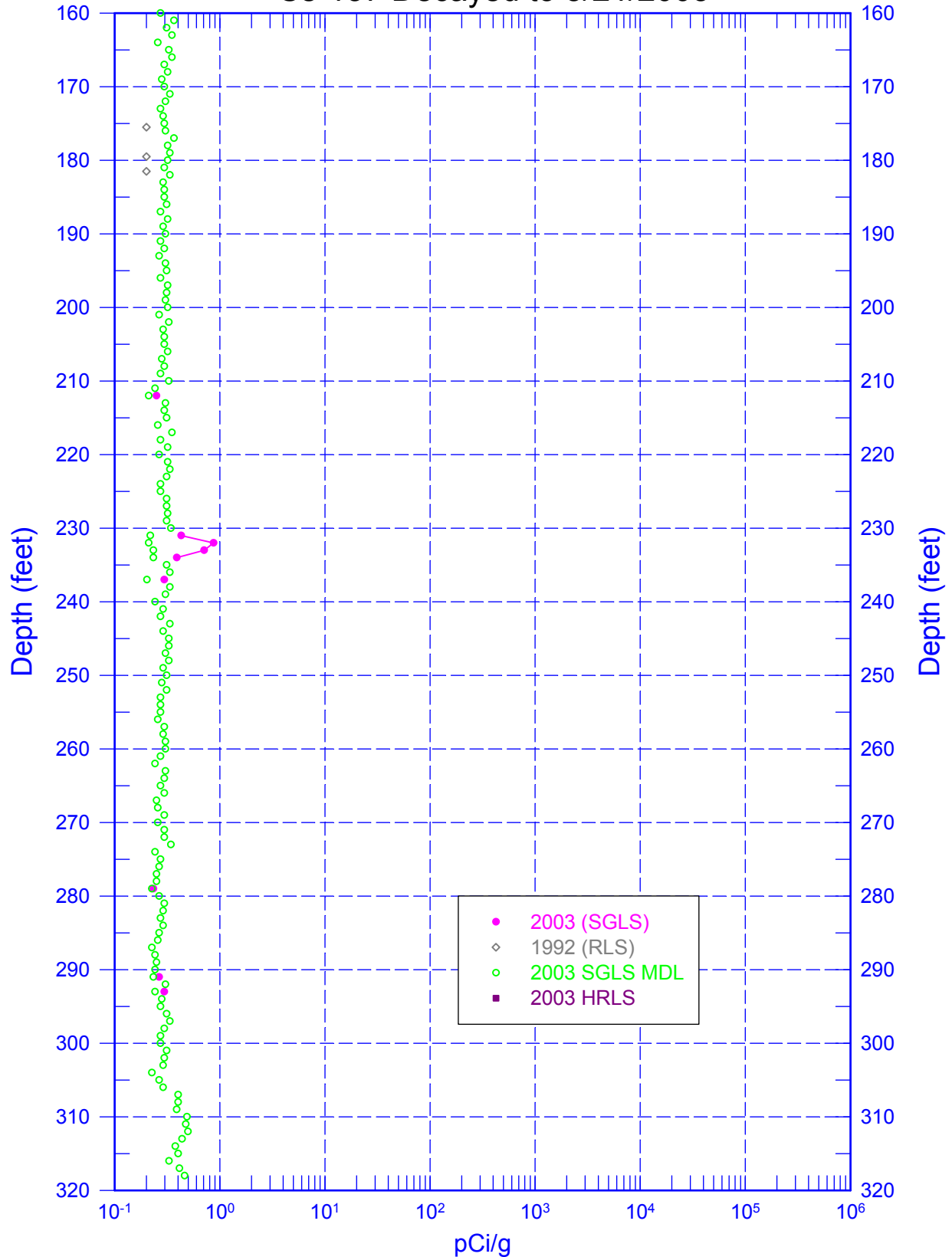
Zero Reference = Top of Casing (2003 SGLS)  
1992 RLS shifted +4 ft to agree with SGLS



# 299-E28-16 (A6794)

RLS Data Compared to SGLS Data

Cs-137 Decayed to 5/21/2003

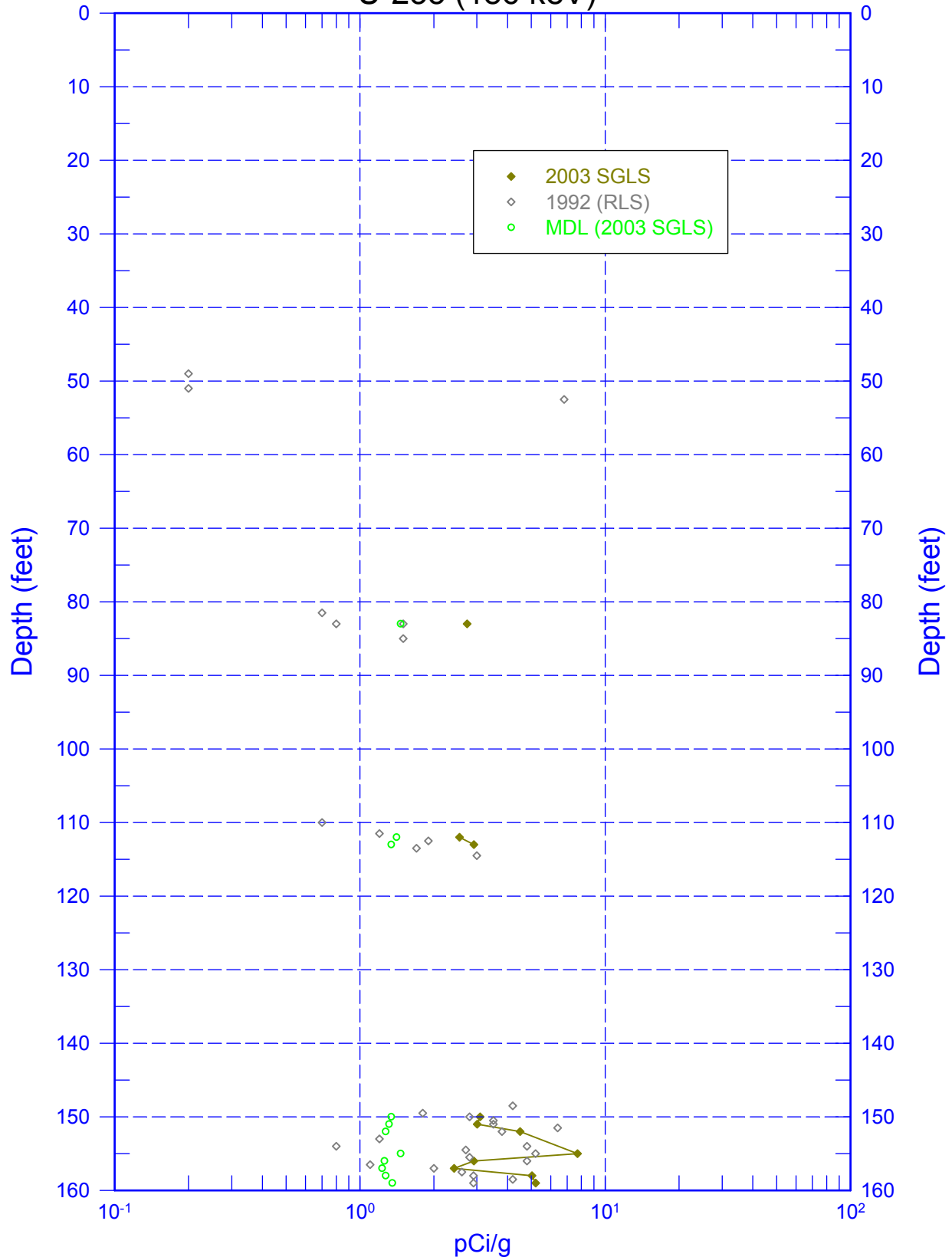


Zero Reference = Top of Casing (2003 SGLS)  
1992 RLS shifted +4 ft to agree with SGLS

# 299-E28-16 (A6794)

RLS Data Compared to SGLS Data

U-235 (186 keV)

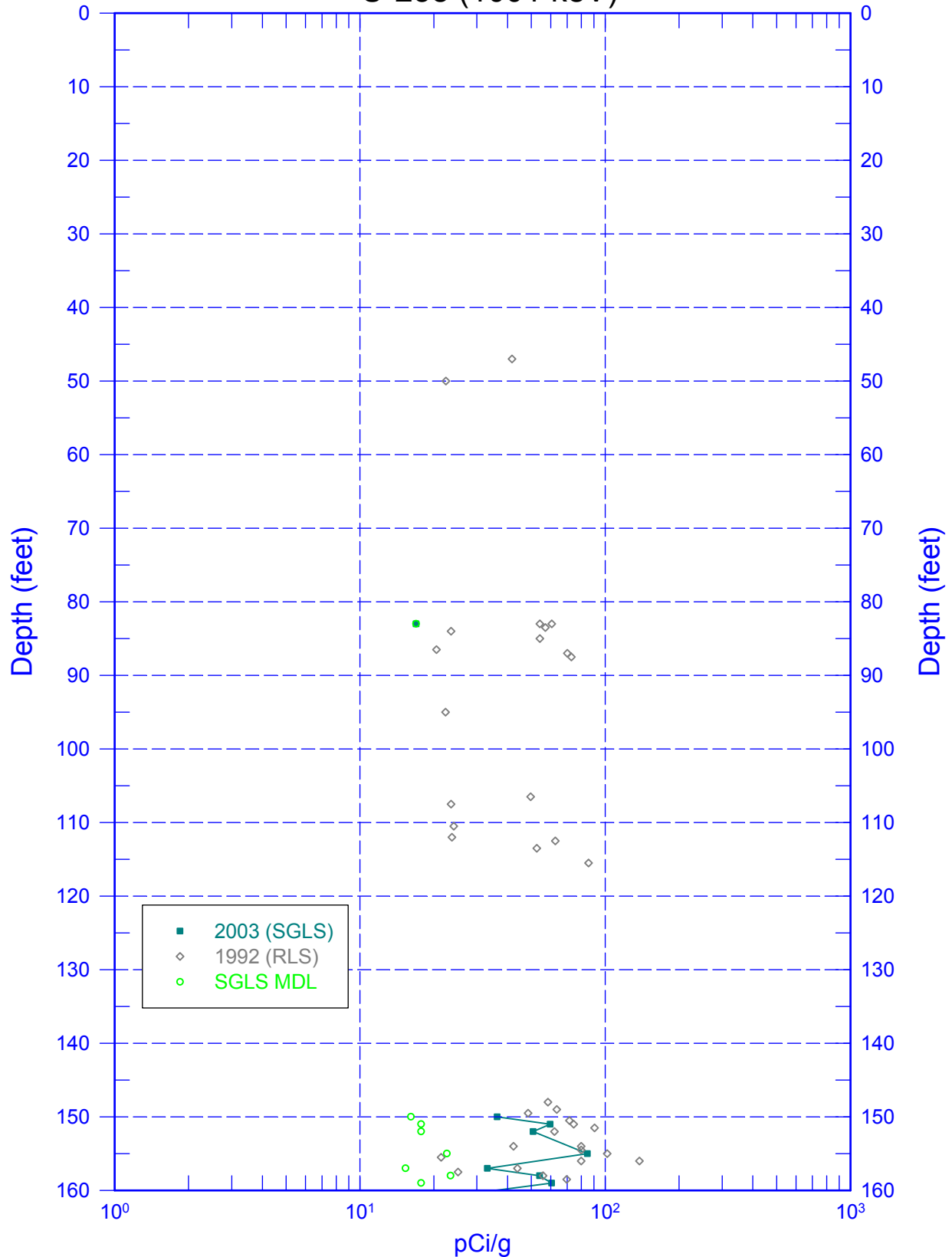


Zero Reference = Top of Casing (2003 SGLS)  
1992 RLS shifted +4 ft to agree with SGLS

# 299-E28-16 (A6794)

RLS Data Compared to SGLS Data

U-238 (1001 keV)

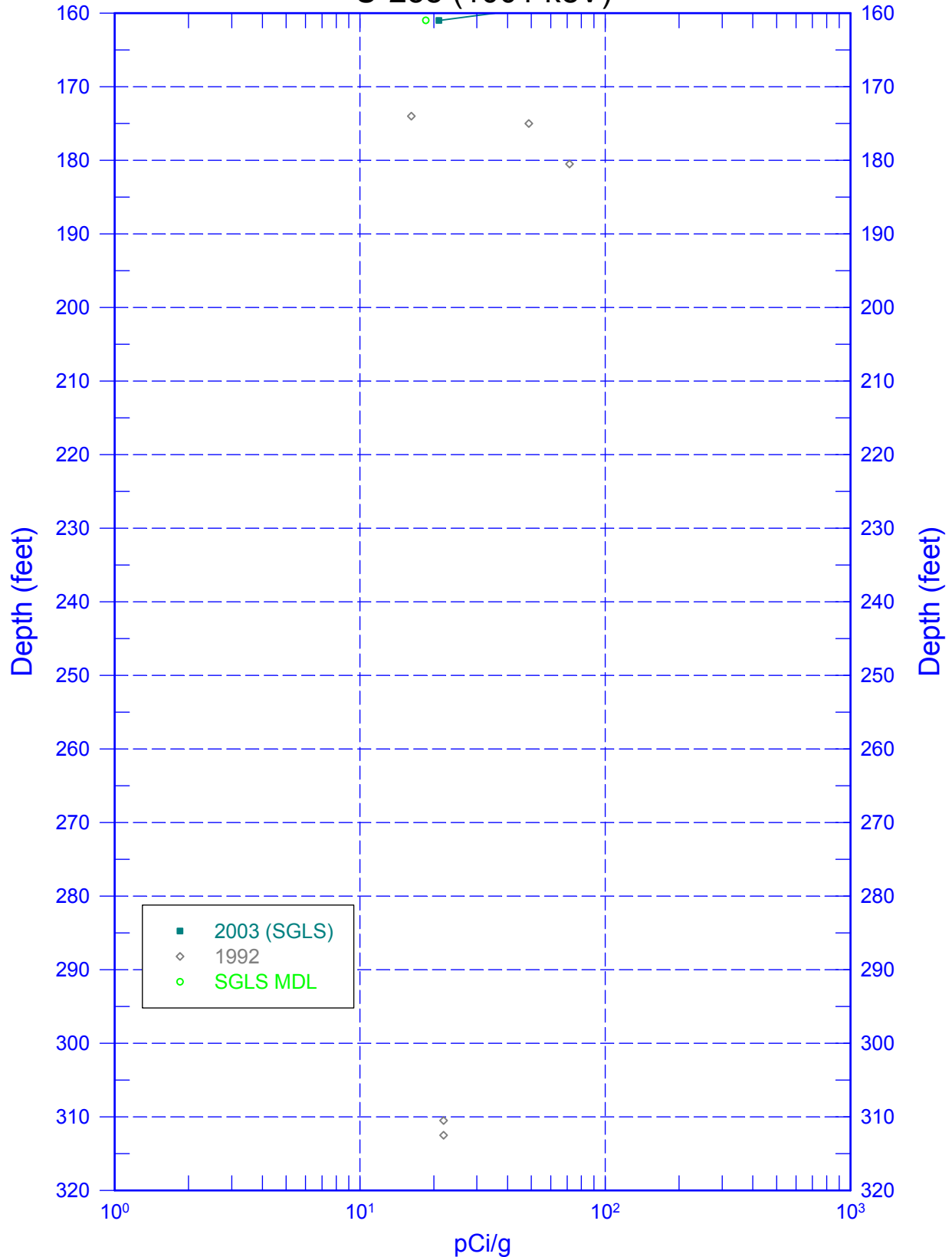


Zero Reference = Top of Casing (2003 SGLS)  
1992 RLS shifted +4 ft to agree with SGLS

# 299-E28-16 (A6794)

RLS Data Compared to SGLS Data

U-238 (1001 keV)



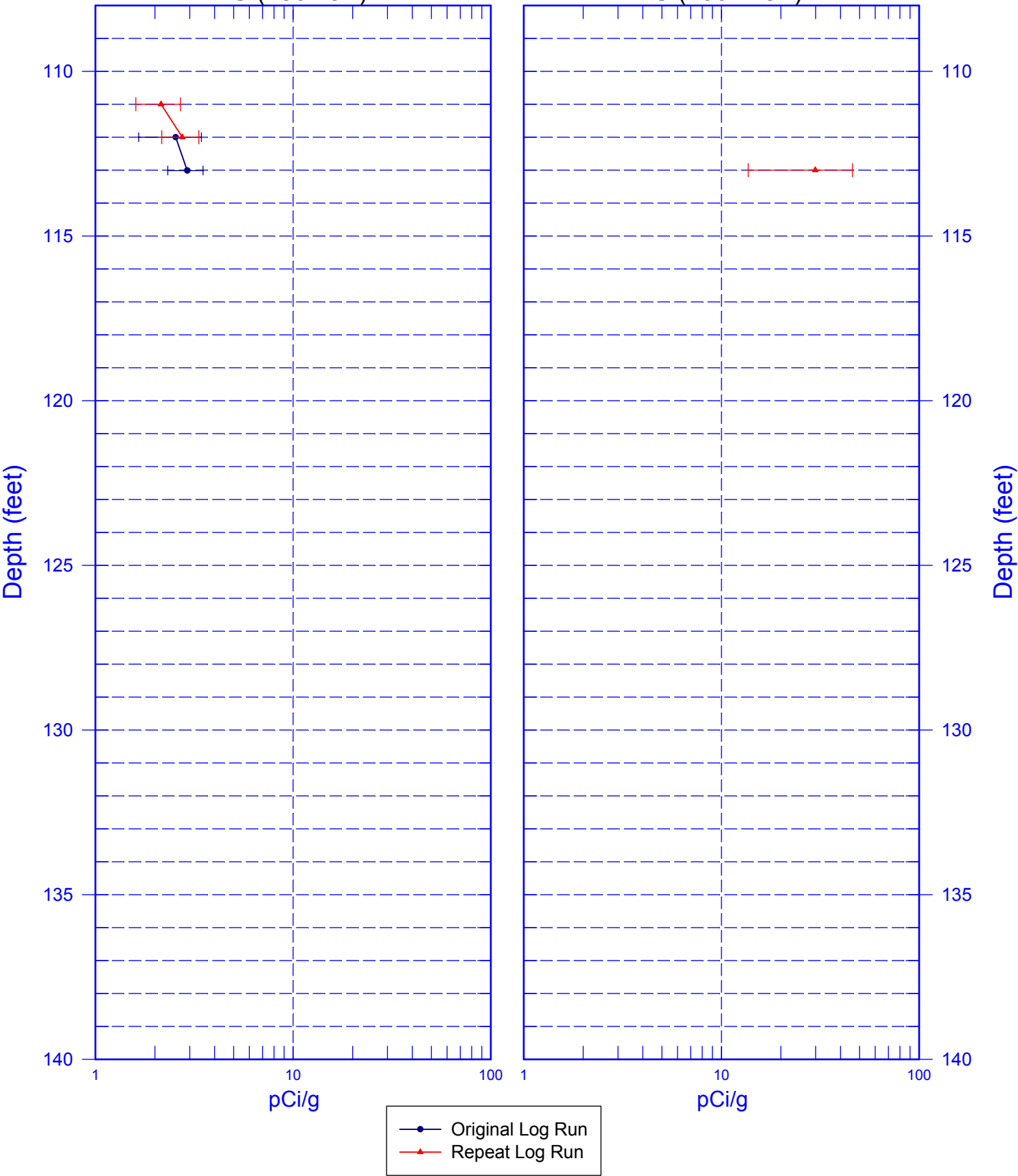
Zero Reference = Top of Casing (2003 SGLS)  
1992 RLS shifted +4 ft to agree with SGLS

# 299-E28-16 (A6794)

## Rerun of Man-Made Radionuclides

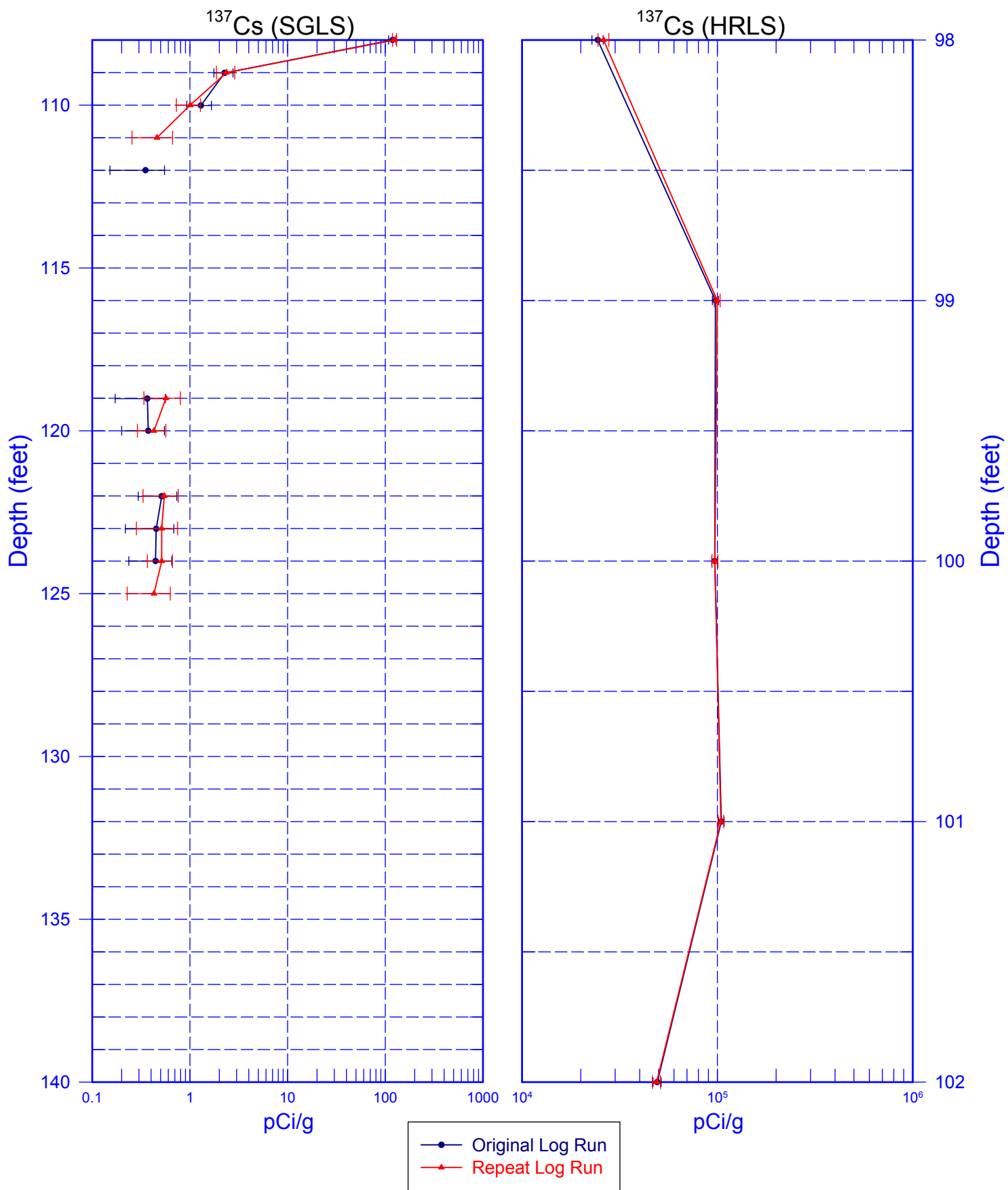
$^{235}\text{U}$  (186 keV)

$^{238}\text{U}$  (1001 keV)



# 299-E28-16 (A6794)

## Rerun of $^{137}\text{Cs}$



# 299-E28-16 (A6794)

## Rerun of Natural Gamma Logs (140.0 to 108.0 ft)

